Name__________________________ Section _______ Date_____________

Pre-Lab Preparation Sheet for Lab 4: Friction

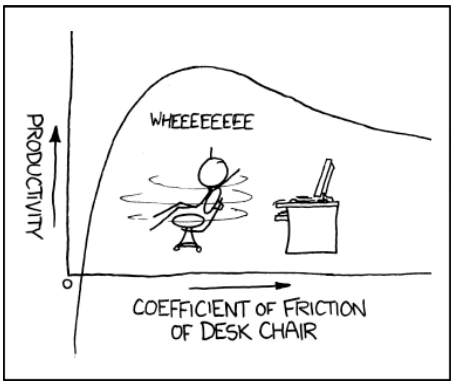
(Due at the Beginning of Lab)

Directions:

Read over the lab and then answer the following questions.

1. What are the units for the coefficients of kinetic and static friction?

2. Write a detailed procedure to measure the coefficient of kinetic friction for a block of wood sliding along a track which would utilize the equipment you are familiar with from previous labs. How would you estimate the uncertainty?
(You may want to use a separate sheet of paper.)



xkcd.com

Name ______________________ Date __________ Partners ________________

TA ________________ Section _______ ________________

Lab 4: Static and Kinetic Friction

Q: How does a physicist milk a cow?

A: First, let's assume a spherical cow . . . .

--old physics joke (Physicists find this hilarious.[*]*)*

Equipment

2.2 meter track	Force sensor
Motion sensor	Mass set
Wooden block	Masonite board[†]

Introduction

Friction is incredibly complicated. A full discipline of science (tribology) is devoted to it. Its basic origins remains a subject of high level research. Nevertheless, in many cases, a very simple model (a so-called *spherical cow*) describes the behavior of friction with surprising accuracy.

If we have two solid materials in contact, we can define two types of friction:

Static friction: the force that keeps two surfaces from slipping. The force of static friction is parallel to the surface. Its magnitude is whatever is required to prevent slippage. Its maximum magnitude is the coefficient of static friction m_s times the normal force n.

$$0 \leq F_s \leq \mu_s n \tag{1}$$

Kinetic friction: a constant force between two slipping surfaces. The force is parallel to the surface, and its direction is opposite the motion. The magnitude is

$$F_k = \mu_k n \tag{2}$$

This model is purely empirical; there is no underlying explanation or principle. The coefficients must be measured on a case by case basis. But this model happens to work well enough to be useful. Note that this model makes several assumptions:

- Friction is binary: static or kinetic, nothing else.

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[*] Sad, I know.
[†] A type of glorified cardboard.

- Kinetic friction is independent of both contact area and velocity.
- While $\mu_s \geq \mu_k$, the coefficients are otherwise unrelated.

Table 1 provides a short list of examples.

Table 1: Friction coefficients

Material 1	*Material 2*	μ_s	μ_k
glass	glass	0.9 – 1.0	0.4
glass	nickel	0.78	0.56
rubber	concrete	1.0	0.8
Teflon™	Teflon™	0.04	0.04

Experiments

1. Along with your lab partners, develop a procedure to measure the coefficient of static friction and corresponding uncertainty for the wooden block and the Masonite board. Clearly describe your procedure and present your results.

2. Along with your lab partners, develop a procedure to measure the coefficient of kinetic friction and corresponding uncertainty for the wooden block and the Masonite board. Also, justify your answers to the following questions:
    a. Is f_k independent of the velocity?
    b. Is f_k independent of the surface area?

    Clearly describe your procedure and present your results.

A question to ponder until the next lab:

Why do race cars have wide tires?